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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

## Racial Variation in Ponderosa Pine at Fort Valley, Arizona

M. M. Larson<sup>1</sup>

*Ponderosa pines from eastern and southeastern seed sources of the species range survived at Fort Valley, whereas trees of northern and western sources failed. In general, sources closest to Fort Valley grew best. Black Hills sources grew well in some instances.*

A ponderosa pine seed source plantation was established at the Fort Valley Experimental Forest near Flagstaff, Arizona, during 1913-17. Results of this provenance study have never been published except for brief mention by Pearson (1950),<sup>2</sup> Roeser (1926), Schreiner (1937), and Squillace and Silen (1962). Also, a typewritten progress report was prepared by Pearson.<sup>3</sup>

The Fort Valley plantation is one of several ponderosa pine seed source studies established at various locations throughout the

West from 1909 to 1926. Squillace and Silen (1962) reviewed the literature pertaining to these studies, and presented results of plantations in Idaho, Washington, and Oregon, based on data collected after the 1955 growing season.

Detailed analysis of the Fort Valley plantation data is limited by poor survival of trees and lack of an experimental design to adequately test source differences. The results, however, do provide additional information to that obtained from the other ponderosa pine seed source tests.

### The Study

Ponderosa pine seed was obtained from 19 National Forests over the range of the species (fig. 1). Collection data are missing except for the local Coconino seed lots, which were all collected near Fort Valley. All the planting stock was grown at Fort Valley, with the exception of two lots of San Isabel stock which were grown at the Monument, Colorado,

<sup>1</sup> Forest Physiologist, Rocky Mountain Forest and Range Experiment Station, located at Flagstaff in cooperation with Northern Arizona University; central headquarters are maintained at Fort Collins in cooperation with Colorado State University.

<sup>2</sup> Names and dates in parentheses refer to Literature Cited, p. 7.

<sup>3</sup> Pearson, G. A. Source of seed--western yellow pine. 14 pp., Jan. 20, 1920. (Unpublished progress report on file at Rocky Mountain Forest and Range Exp. Sta., Flagstaff, Arizona.)

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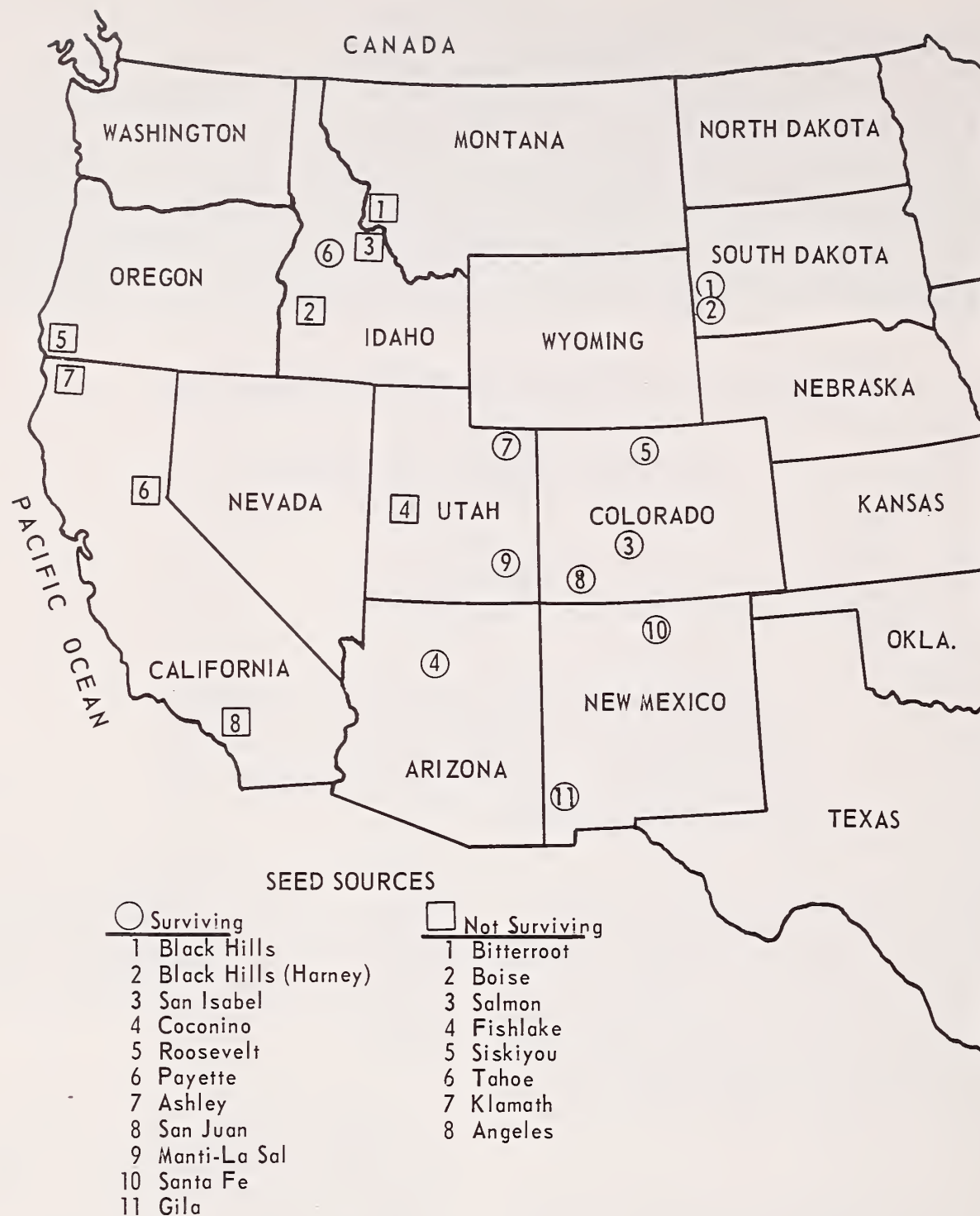


Figure 1.--The geographic location of ponderosa pine seed sources tested at the Fort Valley Experimental Forest, Arizona.

nursery and one lot of Coconino stock which was grown at the Fort Bayard, New Mexico, nursery. Stock was grown to 2-1 transplants and outplanted in 1913, 1914, 1916, and 1917. The main planting site, designated area A-1, was located one-fourth mile west of the Experimental Forest headquarters at an eleva-

tion of 7,300 feet. The soil was gravelly clay loam derived from basalt. All stock was hand planted in east-west rows with a 6-foot spacing between trees and rows. Rows, each a single seed source, varied in length up to 10 chains. Survivors were counted every year until 1919, and then in 1928, 1961, and 1964.



Heights were taken in 1928, and both heights and diameters were measured in 1964, 47 to 51 years after planting.

Untagged trees in the north one-half of area A-1 are excluded from this report. Also excluded are the remnants of three sources decimated by sheep grazing on area D-1, 3 miles northeast of the Experimental Forest headquarters on the San Francisco Peaks.

Comparisons of diameter and height growth between sources are based upon the largest

one-third of the trees in each source, as recommended by Munger (1947) and Squillace and Silen (1962).

## Results and Discussion

Ponderosa pines from 11 of 19 National Forests survived at Fort Valley (fig. 1). Survival, however, was poor--no source exceeded 40 percent (table 1). The survival pattern clearly reveals that sources from the eastern and southeastern part of the species

Table 1. --Growth, survival, and planting year of localities of seed origin

Year stock <sup>1</sup> planted	Locality of seed origin by National Forest	Total planted	Alive (1964)	Survival	Average diameter of 1/3 largest (1964)	Average height of 1/3 tallest (1964)
		Number		Percent	Inches	Feet
1913	San Isabel <sup>2</sup>	288	98	34	6.57	23.3
	Coconino	1,056	241	23	7.22	25.2
1914	Black Hills	273	49	18	7.83	27.6
	San Isabel <sup>2</sup>	319	53	17	6.86	22.1
	Coconino <sup>3</sup>	372	146	39	7.12	25.8
	Coconino	242	44	18	8.46	27.9
1916	Payette	65	1	2	--	--
	Black Hills (Harney)	100	20	20	7.69	25.1
	Roosevelt	200	14	7	5.64	19.8
	San Isabel	100	6	6	6.45	19.0
	Coconino	200	19	10	9.42	28.3
1917	Black Hills (Harney)	52	3	6	6.30	17.0
	Ashley	65	6	9	4.00	21.0
	San Isabel	84	10	12	7.73	27.3
	Manti-La Sal	84	18	21	9.60	28.7
	Santa Fe	84	20	24	8.33	24.6
	Gila	87	5	6	4.90	21.5
	Coconino	914	81	9	8.16	25.3
	Bitterroot	78	0	0		
	Boise	26	0	0		
	Salmon	43	0	0		
	Fishlake	14	0	0		
	Siskiyou	22	0	0		
	Tahoe	12	0	0		
	Klamath	(4)				
	Angeles	(4)				

<sup>1</sup> All stock grown to 2-1 transplants.

<sup>2</sup> Stock grown at Monument Nursery, Colorado.

<sup>3</sup> Stock grown at Fort Bayard Nursery, New Mexico.

<sup>4</sup> All seedlings killed in nursery, November 2, 1916, by freezing (temperature -3°F.).

range survived, whereas northern and western sources were failures. Payette is listed as a surviving source, but only a single tree remained.

Insects and unfavorable weather were the major causes of mortality during the early years.<sup>3</sup> Weather was favorable in 1913 and 1914, but the May beetle larvae killed many seedlings of all sources. The spring of 1916 was unusually dry, and early, hard freezes the following fall killed all the Angeles and Klamath seedlings and nearly all the Tahoe seedlings while still in the nursery. In 1917, a severe fall drought eliminated 6 of the 14 sources planted on the study area the preceding spring.

At the Fort Valley nursery, Pearson<sup>3</sup> observed that seeds of the central and southern

Rocky Mountain sources were smaller and germinated faster without stratification than seeds of northern and western sources. Seedlings of these latter sources, he noted, were greener, taller, formed a more compact crown, and developed "a splendid root system for planting." Yet these northern and western source seedlings, Pearson reported, did not withstand planting well and were sensitive to frost and drought.

Seedling losses between 1928 and 1964 were small and about evenly divided among the sources. The effect of nurseries on survival and growth was usually confounded by the effects of site, stocking, and year of planting. However, Coconino trees from the Fort Valley nursery planted in 1914 grew better than Coconino trees from the Fort Bayard nursery (fig. 2).

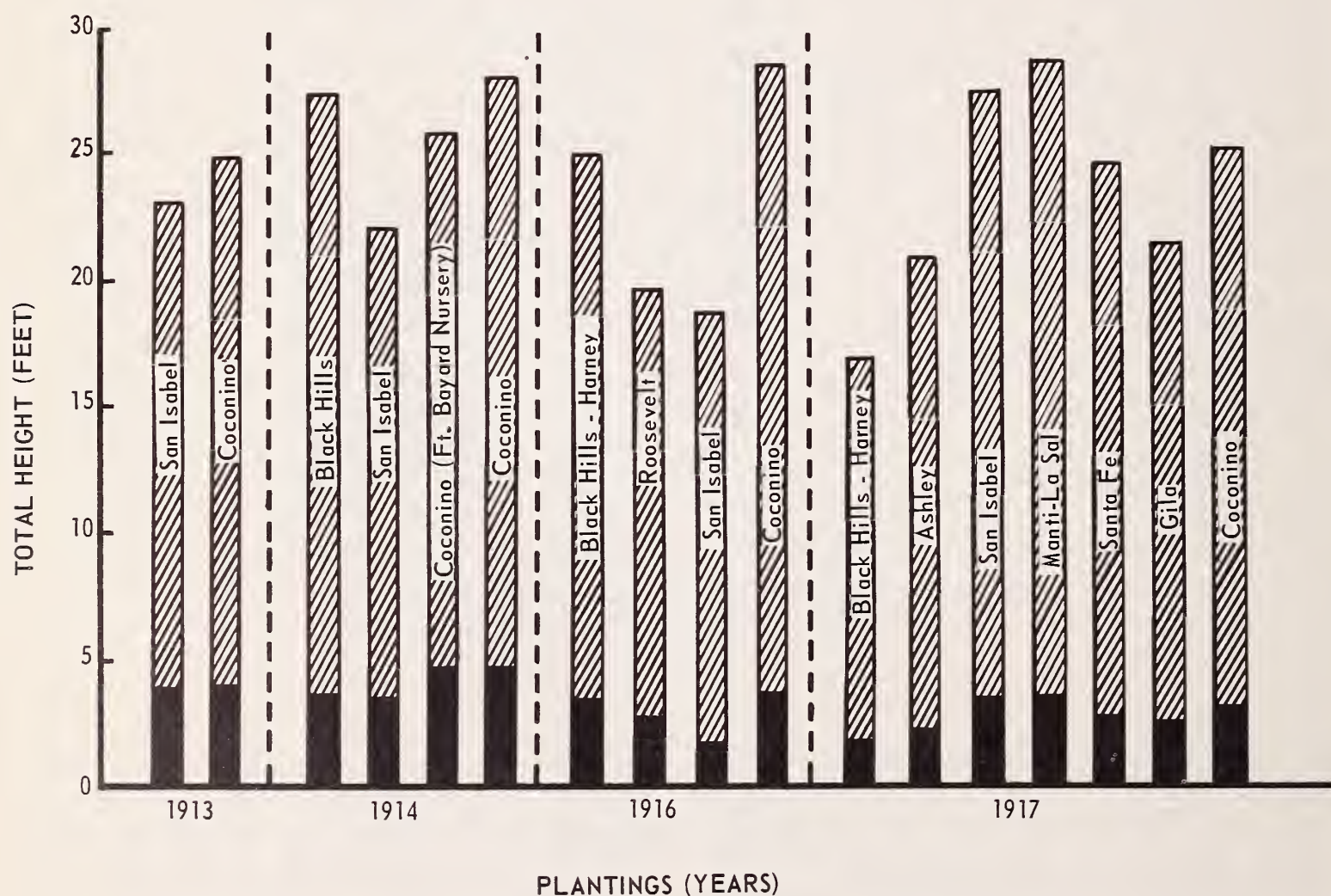


Figure 2.--Total average height of the tallest one-third of the trees from each source in 1928 (solid bar) and in 1964 (diagonal lines) for each planting year.



The local Coconino source trees grew larger in diameter and height than other sources planted in 1913, 1914, and 1916 (table 1, fig. 2). In the 1917 planting, Manti-La Sal source trees from southeastern Utah grew tallest (28.7 feet) with San Isabel second tallest (27.3 feet) and Coconino third (25.3 feet). However, some of the Coconino rows planted in 1917 were located in the lowest and poorest part of the planting area. The tallest trees were usually largest in diameter (table 1).

Roosevelt and San Juan trees were also planted in 1917, but the stock was accidentally mixed together. Growth of these trees was slightly less than that of Coconino trees. Since data for these two sources cannot be separated, none are shown in table 1 or figure 2. The one remaining Payette tree grew only 16.0 feet tall; its measurements are excluded from figure 2.

These data indicate that local Coconino trees and Manti-La Sal trees, the next closest source, grew best at Fort Valley. In contrast, Squillace and Silen (1962) found that trees of southern Rocky Mountain sources, and especially the Coconino source, grew poorly in the northern Idaho and Washington-Oregon tests. They noted, however, that height growth generally decreased with increasing distance of the seed source from the experimental site. A similar trend, with Black Hills source an exception, is suggested in the data reported here.

Sources ranked by height for each planting year remained virtually unchanged between 1928 and 1964 (fig. 2). A test of correlation between 1928 and 1964 average heights of the 1916-17 plantings revealed a correlation coefficient of +0.87, highly significant. Average heights of Coconino trees in 1964 varied little between the 4 planting years. Average heights of other sources varied more, but these averages were usually based on fewer trees. Also, the records indicate that different seed lots were used when a source was planted in more than 1 year, which may have contributed to variation in height between planting years.

Needle characteristics of sources at Fort Valley completely confirm the findings of

Weidman (1939) and Squillace and Silen (1962). Trees from the central Rocky Mountains--Black Hills, Roosevelt, and San Isabel--were typically two-needled rather than three-needled. Also, needles of these sources appeared thicker and averaged 1/2 to 1-1/2 inches shorter than needles of trees from the southern Rocky Mountains.

In 1928, leader growth of San Isabel and Black Hills trees was far in advance of Coconino trees on May 28. Apparently, no other notes of growth periodicity were taken. Squillace and Silen (1962) reported delayed bud bursting of Coconino trees in the Oregon-Washington study, however, and cite data of Daubenmire (1950) which revealed that Coconino trees in the Idaho study started cambial growth 2 weeks later than local sources. Thus, phenological traits seem very reliable indicators of racial differences.

Coconino trees had the straightest stems in 1964 (fig. 3). Other sources appeared somewhat more crooked, and Santa Fe trees were exceptionally gnarled (fig. 4). Except for Santa Fe trees, stem taper appeared to be influenced more by stand density than seed source, although no measurements were taken.

### Summary

Ponderosa pines from eastern and southeastern seed sources of the species range survived at Fort Valley, whereas trees of northern and western sources failed. At the Fort Valley nursery, seedlings of northern and western origin appeared larger and healthier than other sources, but were unable to withstand the frost and drought periods of the Southwest.

In general, sources closest to Fort Valley grew best. Coconino and Manti-La Sal trees were largest of the 11 surviving sources. Black Hills sources grew well in some instances.

Trees from the Black Hills and central Rocky Mountains were typically two-needled; trees from the southern Rocky Mountains grew longer needles, usually in fascicles of three.





*Figure 3.--Coconino source trees (center rows) survived well and formed straight stems in this part of the study area. The two large older trees in the foreground are outside the study area.*



Figure 4.--An example of two Santa Fe trees (foreground) that formed crooked, multiple stems. Not all Santa Fe seed sources would necessarily express this trait.



Coconino source trees formed straighter stems and began leader growth later in the spring than trees from the central Rocky Mountains and Black Hills.

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